

METHODS AND SYSTEMS FOR GENERATING MESSAGES IN
RESPONSE TO A CHANGE IN LOCATION OF A MOBILE SUBSCRIBER

AN APPLICATION FOR
UNITED STATES LETTERS PATENT

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Description

METHODS AND SYSTEMS FOR GENERATING AND SENDING
MESSAGES IN A MOBILE COMMUNICATIONS NETWORK IN RESPONSE
5 TO A CHANGE IN LOCATION OF A SUBSCRIBER

Related Application Information

9/29/01
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~~This application claims the benefit of United States Provisional Patent~~
~~Application Number 60/184,443, filed March 7, 2000, the disclosure of which~~
10 ~~is incorporated herein by reference in its entirety.~~

Technical Field

The present invention relates to methods and systems for generating and sending messages in a mobile communications network. More
15 particularly, the present invention relates to methods and systems for generating and sending messages in a mobile communications network in response to a change in location of a subscriber.

Background Art

Sub B1
20 In mobile communications networks, information regarding mobile subscribers are stored in databases, referred to as home location registers (HLRs) and visitor location registers (VLRs). HLRs permanently store information about subscribers that belong to the network that owns the HLR.

VLRs temporarily store information about subscribers who are currently "roaming" in the area serviced by that VLR. The VLR may belong to the subscriber's home network or to a foreign network. The HLR and VLR store information needed to correctly route voice calls or data communications to the mobile subscriber. This may include international mobile station identification (IMSI), mobile identification number (MIN), mobile directory number (MDN), and mobile station international ISDN number (MSISDN), as well as the IDs of the VLR and MSC with which the subscriber is currently associated. When a mobile subscriber travels from an area controlled by one VLR or MSC to an area controlled by a different VLR or MSC, a series of messages, referred to as mobile application part (MAP) messages, are exchanged to update contact information for the mobile subscriber in the VLR and HLR. In some instances, it may be desirable for the home network service provider to send a message to their mobile subscribers who are roaming in a foreign network, or to a database in response to a change in location of the subscriber. It may also be desirable for the home network service provider to send a message to a foreign subscriber (i.e., a subscriber from a different network provider) who is roaming within the network. Examples of situations in which it may be desirable to send a message to a mobile subscriber in response to a change in location of the subscriber are:

- Sending a greeting or "welcome" message to the roaming subscriber;
- Sending travel information, such as hotels, restaurants, etc. in the area in which the subscriber is roaming;
- Sending advertising information regarding services available in the area; and

- any other type of message that may be of interest to the roaming subscriber.

Although the MAP protocol defines procedures for updating information in registers, such as HLRs and VLRs, the protocol does not specify a means for notifying a network element, such as a short message service center (SMSC) or a presence server, of a change in location of a subscriber. Moreover, the protocol does not specify a method for delivering a message to either of these entities, and thus to the subscriber, in response to a change in location of the subscriber.

10 Accordingly, there exists a need for novel methods and systems for generating messages in response to a change in location of a mobile subscriber.

Disclosure of the Invention

15 Methods and systems for generating messages in response to a change in location of a mobile subscriber include a signaling gateway and an associated message processing platform. The message processing platform may be internal to or external to the signaling gateway. The signaling gateway may perform routing operations similar to those of a conventional
20 signal transfer point. In addition, the signaling gateway may copy messages communicated between an HLR and a VLR in response to a change in location of a subscriber. The message processing platform may correlate these messages, determine when the messages indicate that a subscriber has changed locations, and generate a change location indication message in
25 response to detecting a change in location. The change in location indication

message may contain the same information stored by the VLR, such as the MSISDN and IMSI number for the subscriber, in addition to other pertinent information.

5 The change in location indication message may be sent to any suitable node, such as a short message service center (SMSC) or a presence server. The message processing platform may communicate directly with the SMSC via TCP/IP or another protocol defined by the Public Land Mobile Network (PLMN), or it may communicate indirectly via traditional SS7/MAP protocol. If the receiving node is a short message service center, the short message
10 center may generate a short message service (SMS) message and send the SMS message to the mobile subscriber. If the receiving node is a presence server, the presence server may update presence information for the subscriber in a presence server database. This presence information may be used by others to learn the location and communication medium through
15 which the mobile subscriber will most likely be reachable.

Accordingly, it is an object of the present invention to generate messages in response to a change in location of the mobile subscriber.

Some of the objects of the invention having been stated hereinabove, other objects will be evident as the description proceeds, when taken in
20 connection with the accompanying drawings as best described hereinbelow.

Brief Description of the Drawings

A description of the present invention will now proceed with reference to the accompanying drawings of which:

Figure 1 is a block and message flow diagram illustrating delivery of a short message service message to a home network subscriber roaming in a foreign network according to an embodiment of the present invention;

Figure 2 is a block diagram of internal subsystems of a conventional
5 signal transfer point or signaling gateway suitable for use with embodiments of the present invention;

Figure 3 is a block and message flow diagram illustrating MAP message flow through a signal transfer point with a MAP screening module according to an embodiment of the present invention;

10 Figure 4A is a flow chart illustrating steps performed by the signal transfer point in Figure 3 in processing a MAP message when MAP screening functionality is located internal to the STP according to an embodiment of the present invention;

15 Figure 4B is a flow chart illustrating steps performed by the signal transfer point in Figure 3 in processing a MAP message when MAP screening functionality is located external to the STP according to an embodiment of the present invention;

Figure 5 is a flow chart illustrating exemplary steps performed by a message processing platform in correlating MAP messages transmitted
20 between an HLR and a VLR according to an embodiment of the present invention; and

Figure 6 is a block and message flow diagram illustrating the delivery of a short message service message to a foreign subscriber located in the network of the service provider that generates the short message service
25 message.

Detailed Description of the Invention

Delivering Short Message Service Messages to Home Subscriber

Roaming in Foreign Network

Figure 1 is a block and message flow diagram illustrating the delivery of short message service messages to a subscriber in response to a change in location of the subscriber. In Figure 1, the dashed line separates the home network from the foreign network. For purposes of this example, the term "home network" refers to the network that generates a message in response to a change in location of a subscriber. The term "foreign network" refers to a network other than the home network that is associated with the delivery of information related to the roaming subscriber.

In the illustrated embodiment, the home network includes signal transfer point 100 capable of sending and receiving SS7 messages. Signal transfer point 100 may be any type of conventional signal transfer point, such as the EAGLE® STP available from Tekelec, Inc., of Calabasas, California. The internal architecture of a signal transfer point suitable for use with the present invention will be discussed in detail below.

Although not shown in Figure 1, signal transfer point 100 may consist of a mated pair of STPs, as this is a common deployment in communications networks. In this case, message processing platform 102 would communicate with both STPs in the pair and would correctly correlate messages independent of the STP through which the messages were routed. Alternatively, signal transfer point 100 may be an SS7/IP gateway capable of sending and receiving both SS7 and IP messages between IP nodes. The internal architecture of a signaling gateway suitable for use with the present

invention will be discussed in detail below. The architecture illustrated in Figure 1 may also include a mated pair of SS7/IP gateways.

In the illustrated embodiment, message processing platform **102** is coupled to signal transfer point **100** via a signaling link, which may employ TCP/IP, SS7 or other protocols. Message processing platform **102** may be a workstation, such as a Sun NetraTM server. Software executing on message processing platform **102** performs functions associated with delivering short message service messages to mobile subscribers in response to changes in location of the subscribers, as will be discussed in more detail below. Although message processing platform **102** is illustrated as being separate from STP **100**, the present invention is not intended to be limited to such an embodiment. For example, in an alternative embodiment of the invention, the functionality provided by message processing platform **102** may be integrated within signal transfer point **100**. The integrated embodiment will be described in more detail below.

Short message service center **104** is a network element that delivers short message services to mobile subscribers. Short message services and location updating procedures for GSM networks are described in:

- 1) ETSI ETS 300 974, Tenth Edition, April 2000 (GSM 09.02 Version 5.14.1 Release 1996), Digital Cellular Telecommunication System (Phase 2+), Mobile Application Part (MAP) Specification;
- 2) ETSI TS 100 901 version 7.4.0 1999-12 (GSM 03.40 Version 7.4.0 Release 1998), Digital Cellular Telecommunications

System (Phase 2+); Technical Realization of the Short Message Service (SMS); and

- 3) ETSI TS 100 530 Version 7.0.0 1999-08 (GSM 03.12 Version 7.0.0 Release 1998), Digital Cellular Telecommunications Systems (Phase 2+), Location Registration Procedures.

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Although the details discussed in this document relate to GSM networks, the invention can easily be adapted for use in IS-41 networks as well. Information regarding procedures used in these networks can be found in ANSI/TIA/EIA-
10 41-D-97, Cellular Radiotelecommunications Intersystem Operations, February, 1996.

Gateway mobile switching center **106** communicates with VMSC **110**, which communicates with mobile subscriber handsets, such as handsets **108**, that are not within their local service area. Although not illustrated in Figure 1,
15 such communications typically occur through a base station that contains an antenna and a transmitter for sending the messages to the mobile subscriber **108**. In this illustration, GMSC **106** is also responsible for acting as an SMS-GMSC to deliver short messages from SMSC **104** to a VMSC **110**. Functions performed by mobile switching centers include set up and tear down of calls
20 and delivery of data communications.

Home location register **109** stores information regarding subscribers of the home network. Such information may include the IMSI, MIN, MDN or MSISDN number and the current VLR and/or VMSC associated with each subscriber. Visitor location register (VLR) **116** stores information regarding
25 roaming subscribers. Like HLR **109**, information stored in VLR **116** may

include IMSI, MIN, MDN or MSISDN numbers for the subscriber. In some networks, the functions of VMSC 110 and VLR 116 may be combined into one network entity. For clarity, they are shown as separate entities in Figure 1.

The system illustrated in Figure 1 is adapted to deliver short message service messages to a home subscriber who is roaming in a non-local network in response to a change in location of a home subscriber. In Figure 1, when a home subscriber illustrated by handset 108 moves to a foreign network, handset 108 sends a signal through the base station (not shown) to VMSC 110. VMSC 110 opens a dialogue with VLR 116, requesting the VLR be updated with the roaming subscriber's information. VLR 116 generates a MAP_Update_Location_Request message and sends the update location request message to HLR 109 through STP 100.

Internal STP Architecture

STP 100 includes internal subsystems for processing and routing messages that are similar to those of a conventional EAGLE signal transfer point or an IP⁷ SECURE GATEWAY™ available from Tekelec. A detailed description of the EAGLE® STP may be found in EAGLE® Feature Guide PN/910-1225-01, revision B, January 1998, published by Tekelec, the disclosure of which is incorporated herein by reference in its entirety. Similarly, a detailed description of the IP⁷ SECURE GATEWAY™ may be found in Tekelec publication PN/909-0767-01, revision B, August 1999, entitled "Feature Notice: IP⁷ SECURE GATEWAY™ Release 1," the disclosure of which is incorporated herein by reference in its entirety. The specific functions of the IP⁷ SECURE GATEWAY™ for transmitting and

receiving TCAP messages over an Internet protocol network are described in PCT Publication No. WO 00/35155, the disclosure of which is incorporated herein by reference in its entirety. Similarly, the functional components of the IP7 SECURE GATEWAY™ for transmitting ISUP messages over an Internet
5 protocol network are described in PCT Publication No. WO 00/35156, the disclosure of which is incorporated herein by reference in its entirety.

Figure 2 illustrates the internal subsystems of an EAGLE® STP or an IP7 SECURE GATEWAY™ to which the methods for generating and sending messages to mobile subscribers in response to a change in location of the
10 subscribers according to the present invention may be applied. In the illustrated embodiment, STP or signaling gateway 200 includes the following subsystems: a maintenance and administration subsystem (MAS) 202, a communication subsystem 204, and an application subsystem 206. The maintenance and administration subsystem 202 provides maintenance
15 communications, initial program loading, peripheral services, provisioning capability, alarm processing, and system disks. Communication subsystem 204 includes an interprocessor message transport (IMT) bus that is the main communication bus among all of the subsystems in signaling gateway 200. In a preferred embodiment, the interprocessor message transport bus includes
20 two 125 Mbps counter-rotating serial buses.

Application subsystem 206 includes cards that are capable of communicating with other cards through the IMT bus. Numerous types of application cards can be incorporated in signaling gateway 200. Examples of such cards includes a link interface module (LIM) 208 that provides SS7 and
25 X.25 links, a data communications module (DCM) 210 that provides SS7-to-

TCP/IP and TCP/IP-to-SS7 translation, and an application service module (ASM) 212, a transaction service module (TSM) 214, or a database service module (DSM) 216 that provide global title translation, gateway screening, and other services. While multiple application modules or cards may be simultaneously configured and operatively connected to the IMT bus, it will be appreciated that each card is assigned a unique IMT bus address so as to generally facilitate the internal communication of messages between provisioned cards that are attached to the IMT bus. Once again, a detailed description of the EAGLE[®] STP other than DCM 210 is provided in the above-cited EAGLE[®] Feature Guide and need not be described in detail herein. DCM 210 is described in detail in the above-referenced International Patent Publications.

With regard to communication type modules, DCM card 210 can be used to communicate IP-encapsulated SS7 messages over an IP network, as described in the above-referenced Feature Notice IP7 SECURE GATEWAY[™] release 1.0 publication.

STP with INTEGRATED MAP SCREENING MODULE

An exemplary embodiment of a signaling gateway or signal transfer point that includes a MAP screening module (SM) suitable for use with the present invention is described in the above-referenced provisional patent application, which is entitled, "Methods and Systems for Mobile Application Part Screening." Figure 3 is a block and message flow diagram including a signal transfer point with functionality for screening MAP messages transmitted between an HLR and a VLR when a subscriber changes location.

Referring to Figure 3, STP **100** includes link interface module **308** for sending and receiving SS7 messages over SS7 links. LIM **308** includes of a number of sub-components including, but not limited to: an SS7 MTP level 1 and 2 process **310**, an I/O buffer or queue **312**, HMDC process **314**, MTP GWS process **315** and HMDT process **316**. MTP level 1 and 2 process **310** provides the facilities necessary to send and receive digital data over a particular physical media / physical interface, as well as to provide error detection / correction and sequenced delivery of all SS7 message packets. I/O queue **312** temporarily buffers incoming and outgoing SS7 messages.

HMDC process **314** performs a discrimination function for determining whether an incoming SS7 message packet requires internal processing or is simply to be through switched, i.e., routed to another node. MTP GWS process **315** provides gateway screening on the MTP portion of the message. HMDT process **316** handles internal routing of SS7 message packets that require additional processing prior to final routing.

Interprocessor message transport (IMT) bus **304** provides a reliable transport mechanism for transporting messages between modules in signaling gateway **102**. In a preferred embodiment, IMT bus **304** comprises a dual counter-rotating bus so that traffic can be re-routed in response to a module failure.

SM Service module (SM) **103** performs SCCP and MAP screening functions on messages received from LIM **308** and DCM **336**. In the illustrated embodiment, SM **103** includes SCCP gateway screening (GWS) process **326** for performing gateway screening functions on the SCCP layer of incoming messages, MAP screening process **328** for performing MAP

screening of incoming messages, global title translation process **330** for performing global title translation of incoming messages, copy function **329** for copying selected messages to MPP **102** and HMRT function **332** for routing messages after screening, global title translation and/or MPP copy has been
5 performed.

Although not illustrated in Figure 3, it is understood that SCCP GWS screening process **326** may access one or more internal or external SCCP screening databases, MAP screening process **328** may access one or more internal or external MAP screening databases, and GTT process **330** may
10 access one or more internal or external GTT databases. In order to maintain the databases, SM **103** is coupled to and serviced by an OAM subsystem **335** via an Ethernet connection **333**. OAM subsystem **335** is responsible for administration and maintenance of the databases.

Data communication module (DCM) **336** is adapted to convert
15 incoming IP-encapsulated SS7 messages into SS7 format and encapsulate outgoing SS7 messages in IP packets. In the illustrated embodiment, DCM **336** includes an HMCG process **340** that is responsible for monitoring congestion on the associated DCM linksets, and internally communicating this link congestion information to peer processes on other modules via IMT bus
20 **304**. The link congestion information is used by the HMRT function **332** during outbound link selection operations. It should be appreciated that outgoing SS7 message packets routed through the DCM **336** will be transmitted out of the STP **100** and into an Internet Protocol (IP) network. STP **100** may include an additional LIM and/or DCM **350** for routing the
25 original message to HLR **109**.

As the SS7 communication protocol and the IP communication protocol are not inherently compatible, all SS7 message packets that are to be sent into the IP network **108** are first encapsulated within an IP routing envelope prior to transmission. This IP encapsulation is performed by an IP encapsulation process **342**. The IP encapsulation process **342** is the IP protocol equivalent of the SS7 MTP level 1-2 layer process **310** of the LIM **308**. One type of packet format for encapsulating various types of SS7 messages in IP packets is described in Technical Reference: Transport Adapter Layer Interface 2.0, published by Tekelec (May 31, 2000). However, it is not the intent of the present invention to be limited to this format. Other formats may be used including SCTP/M3UA/M2UA, the EAGLE's STPLAN feature, etc. Alternatively, the messages may be passed to the external platform via traditional SS7 protocol using a LIM card on the STP instead of the DCM.

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STP with External Map Screening Module

As an alternative to the embodiment described above, SM **103** may not contain MAP Screening process **328**. In such an embodiment, all other functionalities of SM **103** would remain the same, and MAP Screening process **328** would then be integrated on MPP **102** instead of on STP **100**.

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MAP Screening Internal to STP

Figure 4A is a flow chart illustrating exemplary steps that may be performed by the processes illustrated in Figure 3 for performing MAP and SCCP screening functions for sending messages transmitted between an

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HLR and a VLR in response to a change in location of a subscriber when MAP screening process **328** is integrated with STP **100**. In step **ST1**, LIM **308** receives an SS7 message signal unit (MSU). In step **ST2**, MTP level 1 and 2 process **310** performs MTP level 1 and 2 processing on the incoming
5 message. In step **ST3**, HMDC function **314** performs message discrimination, e.g., by examining the destination point code or other fields, in the message to determine whether the message is to be internally routed or through switched. In this example, it is assumed that the message is to be internally routed.

In step **ST4**, MTP GWS process **315** is performed on the incoming
10 message. If the message is not screened (i.e., rejected) by MTP GWS, it will be passed to SM **103** as described in step **ST5** below.

In step **ST5**, HMDT process **316** routes the message to the appropriate internal address for further processing. In this example, HMDT process **316** routes the message to SM module **103** for further processing. Once SM
15 module **103** receives the message, in step **ST6**, global title translation process **330** performs global title translation (GTT) on the message. In step **ST7**, SCCP GWS process **326** screens the message based on one or more SCCP parameters in the GTT'd message.

If the message is not screened (rejected) by SCCP screening process
20 **326**, it is passed to MAP screening process **328**. In steps **ST8** and **ST9**, MAP screening process **328** performs MAP screening on the message by examining the parameters in the TCAP/MAP portion of the message. These parameters include, but are not limited to the CgPA and CdPA SSNs, MAP opcode and related fields in the MAP portion of the message. Within the
25 context of the present invention, the MAP Op-Codes that would be subject to

screening would be those for the MAP Update Location Request, MAP Insert Subscriber Data and MAP Update Location Response, although screening could be performed on any MAP Op-Code. If a message meets the screening criteria, it will then be passed to copy function 329. In step ST10, copy function 329 makes a copy of the message and sends the message to MPP 102. If MPP 102 is external to STP 100, copy function 329 passes the message to HMRT function 332. HMRT function 332 routes the message to the card associated with the appropriate outbound signaling link, which in this case is DCM 336. DCM 336 wraps the SS7 message in a suitable IP header and sends the message to MPP 102. Meanwhile, the original message will be passed on to the intended end node unchanged. For example, the original message may be sent to LIM or DCM 350 for transmission to HLR 109 via an SS7 or IP network. In step ST11, if MAP screening function 328 determines that the message is not one of the targeted message types, the message is not copied and is routed to its intended destination.

If MPP 102 is internal to the STP, copy function 329 sends the message to the internal MPP. An internal MPP may reside on SM 103 or on a separate card. If MPP 102 resides on SM 103, copy function 329 may simply send the message to the appropriate MPP process resident on MPP 102. If MPP is not resident on SM 103, copy function 329 may send the message to the card containing MPP 102 over IMT bus 304. MPP 102 will then correlate messages that are part of the same dialogue as described below.

The present invention is not limited to the steps described above for performing MAP screening. For example, using one or any combination of:

OPC, DPC, Orig. SSN, Dest. SSN, CgPA, CdPA and MAP Op-Code is intended to be within the scope of the invention.

MAP Screening--Functionality External to STP

5 Figure 4B illustrated exemplary steps that may be performed by STP
100 and MPP 103 when MAP screening process 328 is external to STP 100.
If MAP screening process 328 is not integrated with STP 100 and is instead
integrated with MPP 102, the process described above will be the same with
the exception that in step ST7, SCCP GWS process 326 will be responsible
15 for sending the message directly to copy function 329 based on parameters in
the SCCP portion of the message, which may include CdPA and CgPA SSNs
or OPC/DPC. In step ST8, if the message is screened by SCCP GWS, the
message is copied to MPP 102 as described above and the original message
is routed to its destination unchanged. In this case, SCCP GWS is configured
20 to copy screened messages rather than discarding them. Once MPP 102
receives the copied message, it passes the message to MAP screening
function 328. In steps ST9 and ST10, MAP screening is performed as
described above. In step ST11, if the result of MAP screenings that the
message is one of the targeted messages (e.g.
25 MAP_UPDATE_LOCATION_REQUEST), the steps detailed below are
followed for correlation and generation of a short message. In step ST12, the
message is not a targeted message, the copy is discarded by MPP 102 and
processing will stop for that message.

Referring back to Figure 1, STP 100 routes the original update location
25 request message to HLR 109. The update location request message is a

mobile application part (MAP) message that contains identification and location information about the subscriber. In the case of a GSM network, this could include the IMSI number, or other subscriber ID, the VMSC number, and the VLR number. Signal transfer point **100** not only routes this message

5 to HLR **109**, but, according to the present embodiment, copies the message and forwards the message to message processing platform **102**, as described above.

In response to the update location request message, HLR **109** exchanges a sequence of MAP messages to VLR **116**. These messages

10 include a MAP_Insert_Subscriber_Data_request that contains the MSISDN number. HLR **109** also sends a MAP_Update_Location Response which contains the HLR number and terminates the HLR ⇌ VLR dialogue. Signal transfer point **100** notes the arrival of both messages and sends copies to message processing platform **102**. The last message in the sequence is the

15 update location response. This message is forwarded from HLR **109** through STP **100** to VLR **116**.

MAP Message Correlation and Location Update

Indication Message Generation

20 Message processing platform **102** includes message correlator/generator **102a** for correlating MAP messages and for generating a change in location indication message. Figure 5 illustrates exemplary steps that may be performed by message correlator/generator **102a** in correlating MAP messages and generating the change in location indication message.

25 Referring to Figure 5, in step **ST1**, message correlator/generator **102a**

receives a copy of a targeted MAP message from MAP screening process
328. Again, this process may be integrated with STP 100 or MPP 102.
According to an important aspect of the present invention, it may be desirable
to send a message to the subscriber only the first time the subscriber registers
5 with a VLR in a non-home network. A subscriber may change VLRs many
times within a single network, including the subscriber's home network. The
location update procedure described herein is performed each time a
subscriber registers with a new VLR, regardless of whether the new VLR is in
a different network from the previous or whether the VLR is in the same
10 network as the subscriber's HLR. Therefore, it is necessary for message
correlator/generator 102a to be able to distinguish two cases: 1) location
update procedures occurring between the HLR and a VLR within the
subscriber's home network, and 2) location update procedures occurring
between the HLR and a non-home network VLR if the subscriber has
15 previously registered with another VLR in that network.

To accomplish this, when a new message arrives, in steps **ST2** and
ST3, message correlator/generator 102a compares the HLR and VLR IDs. In
step **ST4**, if the IDs indicate that the HLR and VLR belong to the same
network (determined by the network code in the ID), the copy of the message
20 is discarded and processing stops for this message. In steps **ST5** and **ST6**, if
the HLR and VLR are in different networks, message correlator/generator
102a consults a Roaming Table that holds a list of IMSIs and the last VLR ID
known to be associated with that IMSI. The stored VLR ID and the received
VLR ID are compared. If they belong to the same network, this indicates the
25 subscriber has simply switched to a new VLR within the same network, and a

new welcome message is not needed. Accordingly, control returns to step ST4 where the copied message is discarded and processing stops for this message. If the stored and received VLR IDs belong to different networks, processing continues as described below.

5 In the location update procedure defined by GSM 09.02 and described above, the VLR initiates a MAP dialogue with the subscriber's HLR. This dialogue will continue for the duration of the location update procedure. The first message in this dialogue may be a update location request, which is identified by its MAP opcode. Per ITU-T Q.771, Functional Description of
10 Transaction Capabilities, each message that is part of a dialogue is identified by a unique dialogue ID in the TCAP portion of the message. It is this dialogue ID that may be used to correlate MAP messages. However, the present invention is not limited to using the dialogue ID to correlate messages. Correlation based on any parameter that appears in MAP messages
15 exchanged between an HLR and a VLR when a subscriber changes locations is within the scope of the invention.

 It should be noted that several different HLR ⇔ VLR dialogues may be taking place simultaneously through STP 100. Therefore, it is necessary that message correlator/generator 102a be able to create individual mobile call
20 location update records to store messages associated with a particular dialogue. As used herein, the term mobile call location update record refers to data stored in memory for call that includes some or all of the parameters from the messages transmitted between an HLR and a VLR in response to a change in location of a mobile subscriber. A mobile call location update
25 record may be identified by the dialogue ID contained in all messages in the

dialogue between the HLR and the VLR. A mobile call location update record may contain an entry for each message in the dialogue. For example, a mobile call location update record according to the present invention may include an entry for the Location Update Request message, an entry for the

5 Insert Subscriber Data message, and an entry for the Update Location Response message. Each entry may include the complete message, a portion of the message, and the time of receipt of each message. However, the present invention is not limited to any particular mobile call location update record format. Any format that contains information relating to the dialogue

10 between an HLR and a VLR when a subscriber changes location is within the scope of the invention.

Returning to the flow diagram in Figure 5, once it has been determined that a subscriber has moved to a non-home network in which the subscriber has not previously registered with a VLR, in steps **ST7** and **ST8**, message

15 correlator/generator **102a** determines whether a mobile call location update record is active for the dialogue. In step **ST9**, if a record is not active, message correlator/generator **102a** creates a record and stores the message or a portion of the message therein. Control then returns to step **ST1** for processing the next received message.

20 A new call record is created even if the message is not the initial message in the location update procedure sequence as defined by GSM 09.02. This is necessary due to the fact that STP **100** may be deployed with a mate STP. In this case, MPP **102** may receive some messages in a sequence from one STP and some from the other STP. Thus, if one STP is

25 experiencing delays in getting messages to the MPP while the other is not, it

may be possible for the Insert Subscriber Data or Update Location Response to arrive at the MPP before the Update Location Request. In order to handle error cases in which, for some reason, all of the messages expected in a sequence are either not delivered or not copied to the MPP, a timeout will be implemented for each mobile call location update record. If all expected messages in a sequence are not received and logged in a mobile call location update record within a specified time, the mobile call location update record and all entries within it will be erased. Each mobile call location update record will be configured in such a way that the expected number of messages in a sequence is known. Therefore, regardless of the order in which the messages are received, a change in location indication message will be generated when all messages in the sequence are received.

Returning to Figure 5, in step **ST10**, if message correlator/generator **102a** determines that a mobile call location update record is active for the dialogue corresponding to the dialogue ID in the received message copy, message correlator/generator **102a** stores the message copy in the record. In step **ST11**, message correlator/generator **102a** determines whether the record has been completed, i.e., whether all of the messages in the dialogue have been received. As discussed above, it is not necessary that the messages be received in order. If the record is not complete, control returns to step **ST1** to process the next received message. In step **ST12**, once the record is completed, message correlator/generator **102a** generates a change in location indication message and sends the message to an SMSC.

The change in location indication message includes the subscriber ID, i.e., the IMSI, MIN, MDN and/or MSISDN numbers, the VLR number, the HLR

number, the MSC number, the date, and the time. The message may be passed directly to the SMSC over any suitable communication medium, such as TCP/IP connection or using the PLMN's specified protocol per GSM 03.40. The message may alternatively be passed indirectly to the SMSC via STP 100

5 and GMSC 106 using traditional SS7 signaling.

Referring back to Figure 1, upon receipt of the change in location indication message, the short message service center generates a short message containing a welcome message, or other message as determined by the operator. The SMSC then forwards this message to GMSC 106. The protocol between SMSC 104 and GMSC 106 is specified by the PLMN. Alternatively, SMSC 104 may forward the message back to MPP 102 which then forwards the message to STP 100. STP 100 then forwards the short message to gateway mobile switching center 106. In either case, once gateway mobile switching center 106 receives the short message, it sends a

10 MAP_Forward_Short_Message, containing the welcome message (or other message), to VMSC 110, which then sends a short message to roaming subscriber 108 via the base station network not shown in Figure 1.

The embodiment illustrated in Figure 1 illustrates exemplary steps that may be performed by a signal transfer point, a message processing platform, and a short message service center in delivering a welcome message or other

20 message to a subscriber that enters a foreign network in response to a change in location of the subscriber. Although in the embodiment illustrated in Figure 1, signal transfer point 100, message processing platform 102, and short message service center 104 are illustrated as separate components, the

25 present invention is not limited to such an embodiment. For example, the

functionality of message processing platform 102 and short message service center 104 may be integrated within signal transfer point 100. In such an embodiment, signal transfer point 100 may include an internal mobile call record generator that correlates and stores call sequence information
5 generated when a mobile subscriber changes locations. Once the last message in response to the change of location is generated, the mobile call record generator notifies a short message service center application of the change in location. The short message service center application sends a short message service message to a gateway mobile switching center. The
10 gateway mobile switching center sends the short message to the VMSC servicing the roaming subscriber. Thus, the present invention includes embodiments in which the message processing platform functionality and/or short message service center functionality are integrated within the signal transfer point 100. In yet another alternative embodiment of the invention, the
15 message processing platform functionality may be integrated with the short message service center, and this combined platform may be external to STP 100.

Delivering Short Message Service Messages to Foreign Subscriber

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Roaming in Home Network

Figure 6 illustrates an exemplary message flow between a signal transfer point, a message processing platform, and a short message service center in delivering an SMS message to a mobile subscriber from a foreign network in response to entry of the mobile subscriber into a home network.
25 The message flow illustrated in Figure 6 is basically the same as the message

flow illustrated in Figure 1 with the exception that the VMSC in the home network delivers the short message to the mobile subscriber **108**. Thus, Figure 6 illustrates a method by which a short message service center, a message processing platform, and a signal transfer point deliver a short message, such as a welcome message, to a foreign subscriber roaming in the service provider's home network. As with the embodiment illustrated in Figure 1, the short message service center and the message processing platform may be separate from or integrated within the signal transfer point without departing from the scope of the invention.

The present invention is not limited to delivering messages to mobile subscribers in response to a change in location of the mobile subscribers. For example, in an alternative embodiment, the present invention may include generating and delivering presence protocol messages to a presence server in response to a change in location of a subscriber. For example, in the embodiment illustrated in Figure 1, when mobile subscriber **108** enters the foreign network, message processing platform **102** may send a presence protocol message, including the subscriber ID, i.e., the IMSI and MSISDN numbers, the VLR number, the HLR number, the MSC number, the date, and the time, to a presence server. The presence server may receive this information and store the information in a presence server database. Subscribers to the presence server database may then use the information to send messages, such as instant messages, to the mobile subscriber.

Although in the embodiments described above with respect to Figures 1 and 6, the message processing platform is coupled to the STP, the present invention is not limited to such an embodiment. For example, the message

processing platform may be coupled to or associated with the HLR or the VLR to correlate MAP messages transmitted between the HLR and the VLR.

In yet another alternative embodiment of the invention, the message processing platform may be similar in structure to the Message
5 Generator/Traffic Simulator (MGTS) available from Tekelec. The MGTS is conventionally used to simulate and monitor SS7 network traffic. According to the present invention, the MGTS can be used to capture MAP messages and generate the MAP change in location indication message described above. In such an embodiment, the MGTS would have a correlation/message
10 generation function similar to that described above with respect to Figure 5.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation—the invention being defined by the claims.